



THE EARTH IS NOT OUR PROPERTY
BUT WE ARE THE PROPERTY OF
THE EARTH. LIVE SIMPLY THAT
OTHERS AND NATURE MAY SIMPLY
LIVE



GREETINGS

BY
MR. SANI EDATTUKARAN
GROUP CHAIRMAN, HGCI

Dear Students, Faculty, and Esteemed Readers,

It is with great pleasure that I extend my heartfelt congratulations on the release of the latest edition of the Technical Magazine by the Automobile Department. This publication stands as a testament to the dedication, hard work, and innovative spirit of our students and faculty, and I am immensely proud to see the growing enthusiasm for excellence in the field of automotive engineering.

May this magazine inspire you all to continue striving for excellence and to take pride in the wonderful work you are doing. Together, we will shape the future of the automotive industry and build a world where technology and sustainability go hand in hand.

Wishing you all continued success in your endeavors!

Warm regards,



MAKING A DIFFERENCE

Holy Grace
Polytechnic College



GREETINGS

BY

MR. BENNY JOHN AYNIKKAL

GENERAL SECRETARY, HGCI

Dear Students, Faculty, and Esteemed Readers,

It is with great pride and immense joy that I extend my heartfelt congratulations to the entire Automobile Department on the successful release of the latest edition of the Technical Magazine. This achievement reflects not only your academic excellence but also your passion, creativity, and commitment to advancing the world of automobile engineering.

I would like to take this opportunity to acknowledge the efforts of everyone involved in bringing this magazine to life — from the contributors and editors to the supportive faculty members who have mentored and guided you. Your teamwork and dedication to this project are truly commendable.

As we continue to strive for excellence in education, I encourage you all to stay curious, stay driven, and keep exploring new horizons. The world of automobiles offers limitless opportunities, and I am confident that the future is bright for each of you as you pursue your dreams and contribute to the betterment of the industry.

Best wishes for your future endeavors.

Warm regards,



GREETINGS

BY

MR. ANTONY MALIEKAL
SECRETARY, HGPC

Dear Students, Faculty, and Esteemed Readers,

I am delighted to extend my warmest congratulations to the Automobile Department on the release of the latest edition of your Technical Magazine. This publication is a wonderful reflection of your hard work, dedication, and the passion you bring to the field of automotive engineering.

I would like to commend everyone who has contributed to this magazine—from the writers and editors to the faculty members who have supported and guided you throughout this process. Your collective effort is a testament to the spirit of collaboration and excellence that defines our institution.

Once again, congratulations to the Automobile Department for this remarkable achievement. May this magazine inspire you all to continue striving for excellence and to make meaningful contributions to the ever-evolving field of automotive engineering.

Best regards,



GREETINGS

BY

MR. SASIKUMAR M G
PRINCIPAL

Dear Readers,

I am excited to welcome you to this edition of our automobile technical magazine. As the automotive industry continues to evolve, staying informed about the latest advancements is more important than ever.

This magazine is a valuable platform for sharing knowledge, insights, and innovations that are shaping the future of our field. I encourage all of our students, faculty, and industry partners to contribute their expertise and creativity, fostering a collaborative spirit that drives progress.

Let's embrace the challenges and opportunities ahead with enthusiasm and dedication. I look forward to seeing how our collective efforts will contribute to a more sustainable and innovative automotive landscape.

Thank you for being part of this journey.
Best wishes,



GREETINGS

BY

VISHNU K.P
HEAD OF DEPARTMENT

AUTOMOBILE ASSOCIATION CHAIRMAN

Dear readers, On behalf of this technical Magazine prepared by the association of automobile department, I am thrilled to extend my warmest congratulations on your outstanding contribution of faculties and students. Your work has not only advanced value of department but has also inspired many students and enthusiasts.

Your dedication reflects the values we cherish at "AUTOALCHEMY". We are proud to highlight your insights in our publication, and we believe your expertise will continue to influence the future of students, department and also the institution.

Once again, congratulations on this well-deserved recognition. Wishing you ongoing success in all your future endeavors!





Holy Grace
Polytechnic College

GREETINGS



BY

PRASOB SANKAR E M

LECTURER IN AUTOMOBILE ENGINEERING
MAGAZINE STAFF EDITOR

Dear Readers, Welcome to this edition of "AUTOALCHEMY" , your premier destination for automotive insights! As the Staff editor, I'm thrilled to share a curated selection of articles, expert reviews, and the latest innovations that are shaping the automotive landscape. In this issue, we dive into key topics, such as new technologies, industry developments, or exciting vehicle features. Our talented team of student writers and faculties has dedicated themselves to bringing you content that is both informative and inspiring.

At "AUTOALCHMEY" , we believe that the automotive world is driven by passion and ingenuity. We invite you to engage with our articles, share your perspectives, and connect with fellow enthusiasts.

Thank you for being a valued part of our work. Here's to exploring the ever-evolving world of automobiles together!



AUTOALCHEMY
A JOURNAL OF AUTOMOBILE ENGINEERING



MAKING A DIFFERENCE

Holy Grace
Polytechnic College

GREETINGS

BY

ANANDU K S

MAGAZINE STUDENT'S EDITOR

Dear Readers, Welcome to the latest edition of AUTOALCHEMY! As your student editor, I'm excited to share our exploration of the ever- evolving world of automobiles.

In this Our team of enthusiastic student writers has put in tremendous effort to deliver fresh insights and engaging content that showcases our passion for the automotive field.

We believe that the future of the automotive industry lies in our hands, and we're eager to share our discoveries with you. Your thoughts and feedback are invaluable to us, so please feel free to reach out!

Thank you for being part of our community. Let's embark on this journey through the fascinating world of automobiles together



DEPARTMENT OF AUTOMOBILE ENGINEERING

VISION

To generate value for students and other stakeholders in Automobile Engineering by consistently working towards the overall development of students, attaining an all-round in academic excellence, and promoting professional skills, social responsibilities and co-curricular activities

MISSION

M1- To ensure significant engagement in automobile engineering by imparting contemporary knowledge to students.

M2- To develop industry ready students by knowing the present needs of Automotive sector

M3- Promote social responsibility and cultivate entrepreneurial skills within the automobile industry.



MAKING A DIFFERENCE

Holy Grace
Polytechnic College



iEGR Technology in Ashok Leyland vehicles

ABHINAV BABU

2301050915

Ashok Leyland, a leading Indian commercial vehicle manufacturer, developed an advanced EGR-based emission control system called iEGR (Intelligent Exhaust Gas Recirculation) to help its diesel engines meet stringent emission norms such as BS-IV without using the more complex and costly SCR (Selective Catalytic Reduction) system.





What Is iEGR Technology?

iEGR (Intelligent Exhaust Gas Recirculation) is Ashok Leyland's enhanced version of traditional EGR technology. It involves recirculating a portion of the exhaust gases back into the engine's intake air, which reduces the peak combustion temperature and thereby lowers the formation of nitrogen oxides (NO_x)—a key pollutant regulated under emission norms.

In contrast to standard EGR, the “intelligent” part of iEGR lies in the way Ashok Leyland integrates it with improved engine combustion management and a common-rail fuel system to optimize engine performance and emission control simultaneously.

Why Ashok Leyland Developed iEGR

When India introduced BS-IV emission standards, manufacturers had two main technical routes to comply:

- SCR (Selective Catalytic Reduction), which uses urea (AdBlue) and an after-treatment system to reduce NO_x, and
- EGR, which reduces NO_x by recirculating exhaust gases.

Ashok Leyland chose to focus on an advanced EGR system for several reasons:

- Lower cost and simpler maintenance compared to SCR systems that require AdBlue supply and additional sensors.
- Better suitability for Indian operating conditions, where consistent fuel quality and DEF (diesel exhaust fluid) supply can be a challenge.
- Reduced complexity and weight versus SCR, resulting in improved payload potential.

This led to the development of the in-house iEGR technology over several years of R&D by Ashok Leyland engineers.



How iEGR Works

At its core, iEGR operates like conventional EGR by:

1. Diverting a controlled portion of exhaust gas into the intake manifold.
2. Mixing the exhaust gas with incoming air to reduce oxygen concentration in the combustion chamber.
3. Lowering peak combustion temperatures, which reduces the formation of NO_x emissions

What makes iEGR special is that Ashok Leyland combines this with improved in-cylinder combustion management (through engine calibration and common-rail fuel systems), resulting in:

- Better control over injection pressure and timing
- Reduced soot formation compared to earlier EGR systems
- Improved overall combustion efficiency
- Enhanced fuel economy and engine responsiveness

Benefits of Ashok Leyland's iEGR Technology

1. Compliance with Emission Norms

iEGR enabled Ashok Leyland to meet BS-IV emission standards for a wide range of commercial vehicle engines (typically from 130 PS up to 400 PS) without SCR.

2. Better Fuel Efficiency

Because iEGR enhances combustion efficiency and reduces losses, vehicles with this technology reported up to around 10 % improvement in fuel economy compared to the earlier BS-III models.

3. Reduced System Complexity

Compared to SCR technology, iEGR avoids the need for urea tanks, dosing systems, and associated accessories leading to simpler maintenance.

4. Cost-Effectiveness

Lower upfront cost and easier servicing make iEGR especially valuable for cost-conscious commercial vehicle buyers in markets like India.

5. Large Scale Adoption

Ashok Leyland sold over 100,000 vehicles equipped with iEGR technology, demonstrating its acceptance in real-world conditions.



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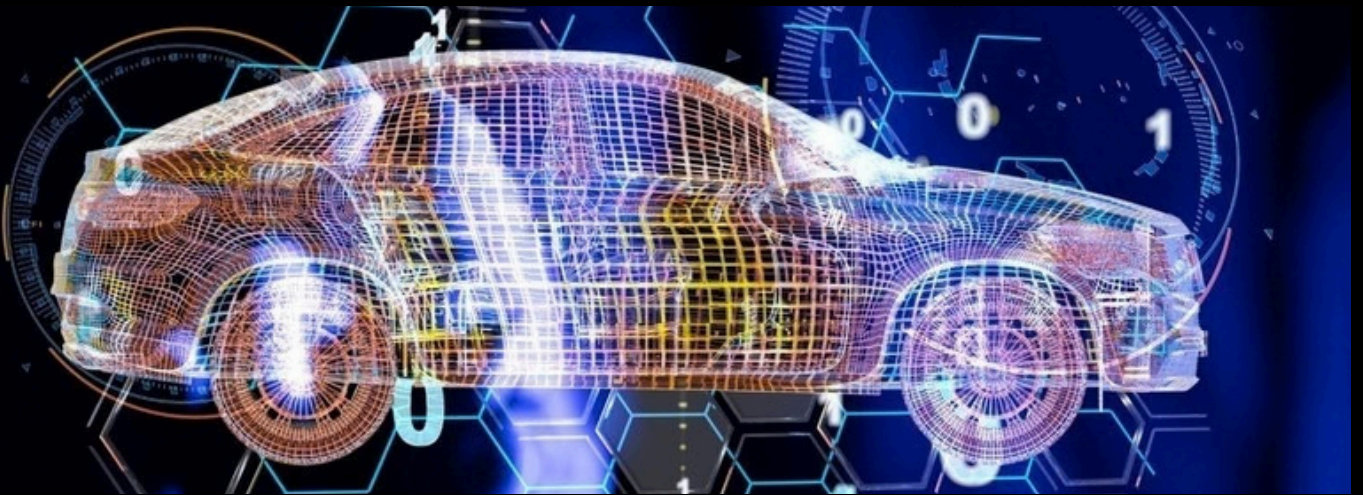
Current Relevance

While iEGR helped AshokLeyland meet BS-IV norms, the industryhasnow moved to BS-VI standards, whicharestricter. For BS-VI, manufacturers—includingAshok Leyland—typically combinemultipleemission control technologies suchasadvanced EGR systems plus after-treatment(SCR,DPF, etc.) to achieve compliance, especiallyforheavier vehicles.

Ashok Leyland's iEGR technology represents an innovative evolution oftraditional EGR systems. By intelligently integratingEGR with enhanced combustion managementand common-rail fuel systems, the companyachieved emission norm compliance for dieselengines while improving fuel economy and reducing cost and complexity. Designed with Indianoperating conditions in mind, iEGR became a keydifferentiator for Ashok Leyland's commercialvehicles in the BS-IV era and laid groundwork forfurther emission-control advancements.

Smarter Manufacturing in the Automobile Industry for Sustainability

2301050916
ADHITH K VINOD



The automotive industry is one of the largest consumers of energy and natural resources, contributing significantly to greenhouse gas emissions.

With growing environmental concerns, stricter government regulations, and customer demand for sustainable products, automobile manufacturers are increasingly adopting smarter manufacturing practices. These practices aim to reduce environmental impact, improve resource efficiency, and promote sustainability across the entire vehicle lifecycle.

What Is Smarter Manufacturing?

Smarter manufacturing refers to the integration of advanced technologies, data-driven decision-making, and lean processes to optimize production. It combines

- Automation and robotics for precision and efficiency
 - Digital technologies such as IoT, AI, and big data analytics
- Sustainable materials and processes to reduce energy and waste
- Circular economy principles to recycle and reuse resources

In the context of the automotive industry, smarter manufacturing focuses on producing vehicles more efficiently while minimizing environmental impact.



Key Technologies in Smarter Manufacturing

2301050921
BHARATH K P

1. Industry 4.0 & IoT

- > Real-time monitoring of machines and processes
- > Predictive maintenance reduces downtime and energy use
- > Optimizes production schedules to save resources



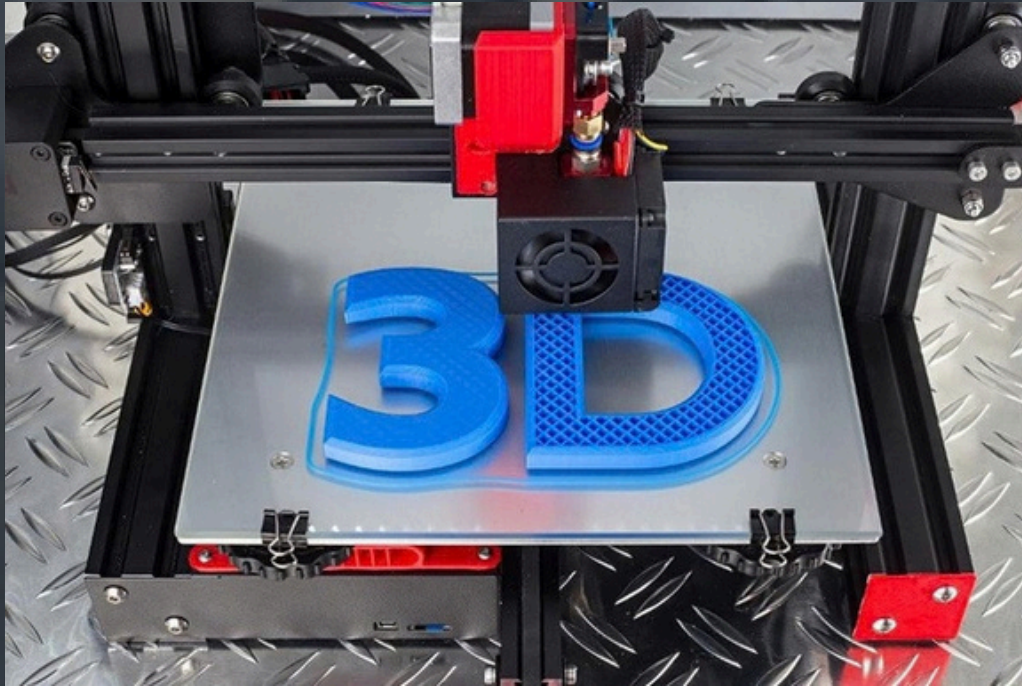
2.Automation & Robotics



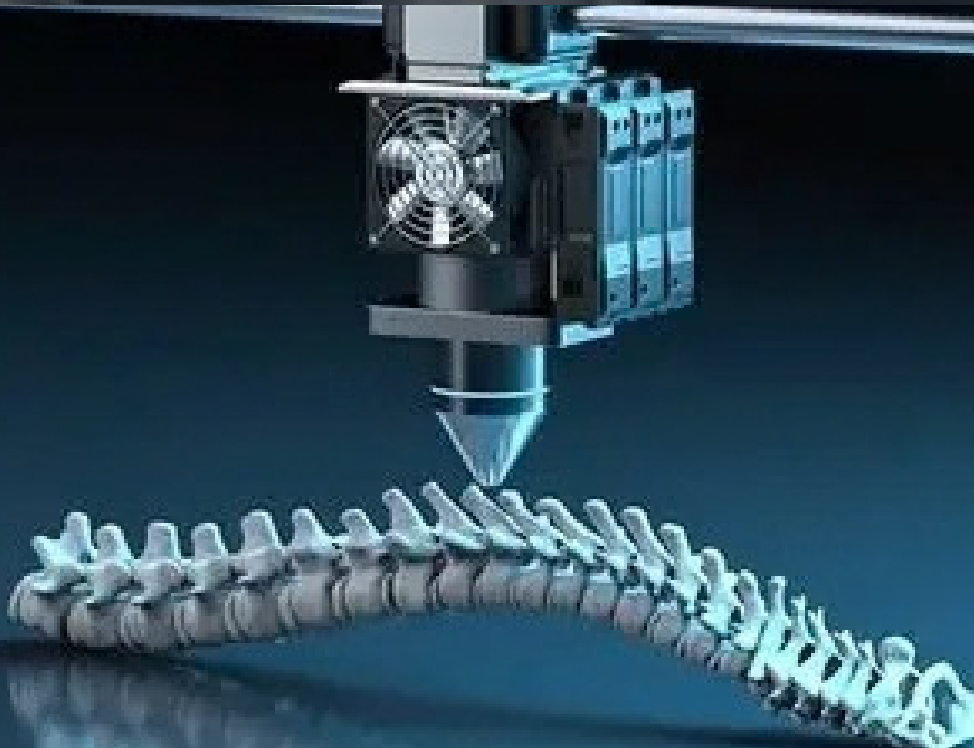
- >Increases precision in assembly and painting
- >Reduces material waste
- >Improves worker safety by handling hazardous tasks



3. Additive Manufacturing (3D Printing)



- > Produces lightweight, high-strength components
- > Reduces material waste and energy consumption
- > Speeds up prototyping and production cycles



4. Digital Twins



- > Virtual replicas of production lines to simulate, monitor, and optimize manufacturing processes
- > Helps in identifying inefficiencies before actual production
- > Reduces energy use and resource consumption

5. Artificial Intelligence (AI) & Machine Learning



- > Optimizes supply chain and production efficiency
- > Predicts demand to reduce overproduction and inventory waste
- > Enhances quality control and defect detection

Sustainable Practices in Smarter Manufacturing

2301050922
DELVIN DAVIS

Energy Efficiency

- Use of renewable energy sources like solar and wind in factories
- Installation of energy-efficient motors, lighting, and HVAC systems

Material Efficiency

- Lightweight materials like aluminum, carbon fiber, and recycled plastics
- Reducing scrap and reusing materials in production

Water and Waste Management

- Recycling water in painting and cooling processes
 - Treating and reusing industrial wastewater
- Zero-waste-to-landfill initiatives in manufacturing plants

Eco-friendly Paints & Coatings

- o Water-based and powder coatings reduce volatile organic compounds (VOCs) emissions

Circular Economy in Automotive Production

- o Remanufacturing engine parts and batteries
- o Designing vehicles for easier disassembly and recycling



Benefits of Smarter Manufacturing for Sustainability:

1. Environmental Impact Reduction: Lower CO₂ emissions, reduced water and energy consumption
2. Cost Efficiency: Optimized production reduces energy and material costs
3. Regulatory Compliance: Meets increasingly strict environmental and emission regulations
4. Innovation & Competitiveness: Enables development of greener vehicles like electric vehicles (EVs)
5. Consumer Trust: Eco-friendly manufacturing enhances brand reputation



Examples from the Automotive Industry

Toyota – Lean manufacturing combined with renewable energy and waste reduction programs.

Tesla – Gigafactories powered by renewable energy with extensive use of automation.

BMW – Digital twin technology to optimize production and minimize energy usage.

Mahindra & Mahindra – Adoption of smart assembly lines and water recycling in plants.



Challenges

High initial investment in advanced technologies

Integration with legacy manufacturing systems

Need for skilled workforce to manage digital systems

Continuous innovation required to keep up with sustainability standards

Future Outlook

- Industry 5.0: Human-centric, sustainable manufacturing powered by AI, IoT, and robotics
- Green Supply Chains: Integration of smarter manufacturing with eco-friendly logistics
- Renewable Energy Integration: Fully energy-neutral plants for automotive production
- Circular Vehicle Economy: Vehicles designed for full recyclability, remanufacturing, and reusing components

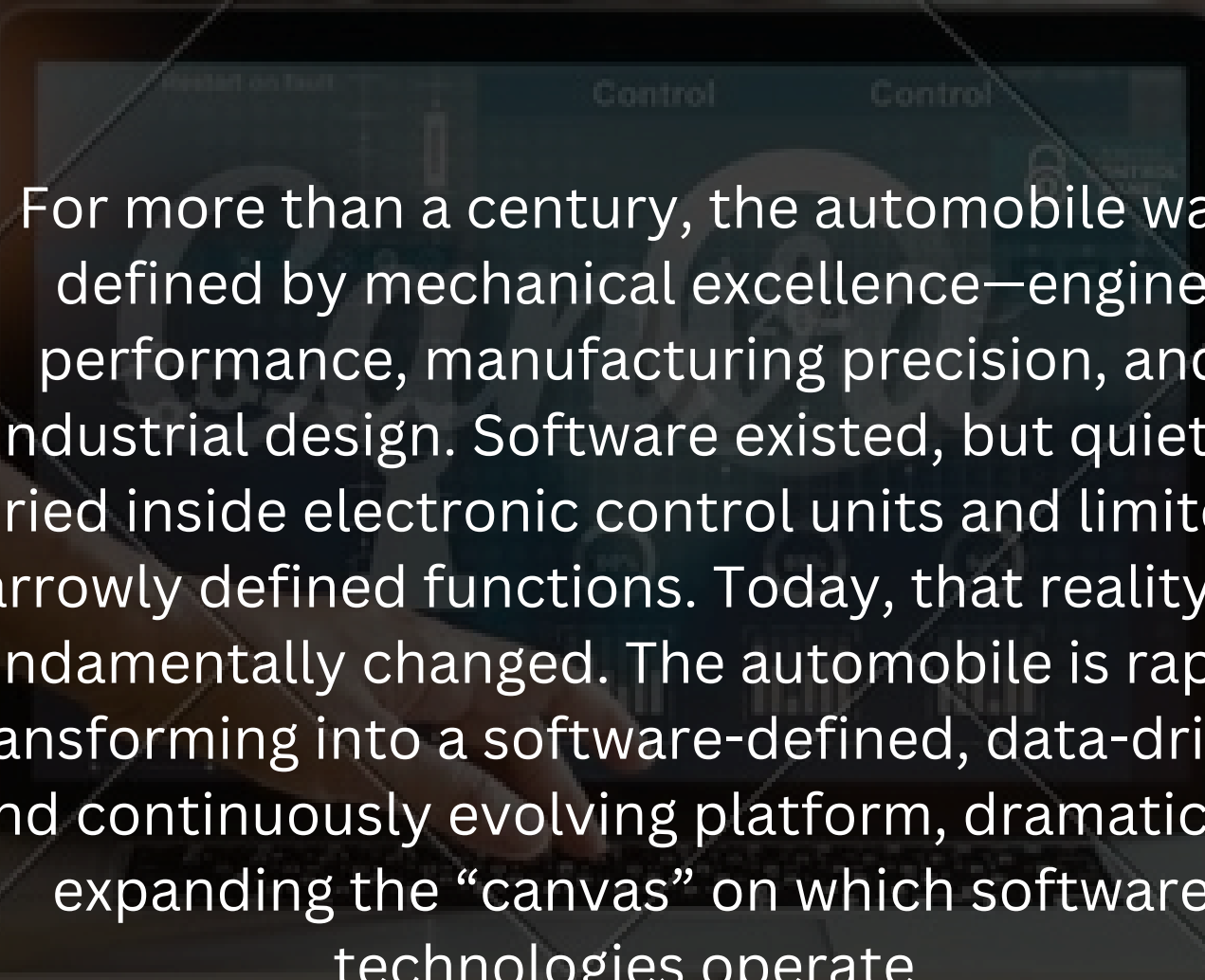


Smarter manufacturing in the automotive industry is not just about efficiency—it is a pathway toward sustainability. By combining digital technologies, automation, eco-friendly materials, and resource optimization, manufacturers can produce cleaner, greener, and safer vehicles while reducing environmental impact. This approach supports the global goal of sustainable mobility and ensures the industry remains competitive in a resource-constrained world.

The Expanding “Canvas” of Software Technologies in the Automobile Industry

2301050928

JUDSON SAJI

A background image showing a hand touching a car's infotainment screen. The screen displays a 'Control' interface with various icons and text. The overall image has a dark, textured background with a diamond pattern.

For more than a century, the automobile was defined by mechanical excellence—engine performance, manufacturing precision, and industrial design. Software existed, but quietly, buried inside electronic control units and limited to narrowly defined functions. Today, that reality has fundamentally changed. The automobile is rapidly transforming into a software-defined, data-driven, and continuously evolving platform, dramatically expanding the “canvas” on which software technologies operate.

This expansion is reshaping not only how vehicles are built, but also how they are experienced, monetized, and improved over time.

From mechanical product to software-defined vehicle



Traditionally, automotive software was tightly coupled to hardware purpose-built for specific components, and rarely updated after a vehicle left the factory. Innovation cycles were measured in years, aligned with new vehicle models.

The emergence of software-defined vehicles (SDVs) marks a sharp break from this model. In SDVs, software is abstracted from hardware, centralized compute replaces dozens of discrete controllers, and functionality can be added or refined long after purchase through over-the-air (OTA) updates. This architectural shift dramatically increases the scope and longevity of software inside the vehicle. As a result, cars are no longer static products—they are dynamic systems that evolve throughout their lifecycle.

A layered and expanding software canvas

The modern automotive software landscape can be understood as a multi-layered canvas, each layer enabling new forms of innovation.

1. Vehicle control and safety systems

At the foundation are real-time systems responsible for braking, steering, power management, and safety. These systems must meet stringent requirements for reliability, latency, and functional safety. While highly regulated, even this layer is becoming more programmable, with standardized platforms such as AUTOSAR and real-time operating systems enabling reuse and scalability.

2. Intelligence and autonomy

Above the control layer lies the intelligence stack: advanced driver assistance systems (ADAS) and autonomous driving technologies. Here, software takes on responsibilities traditionally handled by human drivers—perception, prediction, and decision-making. Machine learning models process massive streams of sensor data, while simulation and digital twins accelerate development and validation.

This layer represents one of the most software-intensive and data-hungry domains in the industry.

3. Connectivity and cloud integration

Modern vehicles are deeply connected to the cloud. OTA updates, remote diagnostics, vehicle-to-everything (V2X) communication, and fleet analytics extend the software canvas beyond the physical vehicle. Cars now operate as distributed systems, coordinating between edge compute onboard and cloud platforms offboard.

4. User experience and applications

The vehicle cockpit has become a digital environment. Infotainment systems, voice assistants, AI copilots, and personalized driver profiles are redefining the in-car experience. Increasingly, vehicles support app ecosystems that resemble those of smartphones, opening the door to third-party developers and continuous UX innovation.

5. Data and services

Every modern vehicle generates vast amounts of data. Software technologies transform this data into actionable services: predictive maintenance, usage-based insurance, energy optimization for electric vehicles, and behavioral insights. In this layer, the car becomes not just a mode of transport, but a data-generating asset.

Ecosystem expansion beyond traditional automakers:

As the software canvas expands, ownership of innovation is no longer limited to original equipment manufacturers (OEMs). Technology companies, startups, cloud providers, AI firms, and even independent developers now play central roles in shaping the automotive experience.

This shift replaces traditional linear supply chains with platform ecosystems, where collaboration and competition coexist. Automakers increasingly resemble system integrators and platform operators rather than purely manufacturing-driven organizations.

New business models driven by software
The expanding software canvas is also transforming automotive economics. Revenue is no longer confined to the point of sale. Software enables:

- Feature subscriptions and on-demand upgrades
- Tiered autonomy and performance offerings
- Post-sale monetization through digital services
- Continuous customer engagement throughout vehicle ownership

These models align the automobile industry more closely with software-as-a-service thinking, emphasizing long-term value creation over one-time transactions.

Strategic and cultural implications:

The growth of automotive software reshapes how companies operate internally. Development cycles accelerate, DevOps practices enter vehicle engineering, and cross-disciplinary collaboration becomes essential. Talent strategies shift toward software engineers, data scientists, and cybersecurity experts—skills once peripheral to automotive organizations.

At the same time, challenges intensify: ensuring safety and security at software speed, managing long vehicle lifecycles, and navigating regulatory complexity.

The expanding “canvas” of software technologies in the automobile industry represents a profound transformation. Vehicles are becoming programmable platforms, embedded in digital ecosystems and continuously refined through code. This shift redefines competition, innovation, and customer expectations.

In the future, the success of automotive companies will depend less on mechanical differentiation alone and more on their ability to design, scale, and orchestrate software across this ever-growing canvas. The car, once a finished product, is now an evolving digital experience—and software is the brush shaping its future.



AI in Automobile Design: Transforming Creativity, Engineering, and Innovation

**2301050930
MANAS KRISHNA M P**

Automobile design has long balanced artistic vision with engineering precision. From sketching body lines to validating structural safety, the process traditionally required years of iteration, physical prototyping, and specialized expertise. Today, artificial intelligence (AI) is fundamentally reshaping this landscape. By augmenting human creativity and accelerating technical decision-making, AI is redefining how vehicles are imagined, designed, and brought to life.



The role of AI in modern automotive design:

AI in automobile designing goes beyond automation. It acts as an intelligent collaborator, capable of processing vast datasets, identifying patterns, and generating optimized design solutions. This enables designers and engineers to explore more ideas, reduce development time, and improve performance while maintaining brand identity and safety standards.



AI-driven concept and styling design:

In the early stages of vehicle development, AI tools support ideation and visualization:

- Generative AI creates multiple styling concepts based on design constraints, brand language, and market trends
- Text-to-image models enable rapid visualization of exterior and interior concepts
- AI analyzes historical and competitive designs to predict consumer preferences

These capabilities allow designers to explore a wider creative canvas while retaining full artistic control.

Generative design and engineering optimization:

One of the most impactful applications of AI is generative engineering. AI algorithms generate and evaluate thousands of component designs based on defined goals such as weight reduction, strength, durability, and manufacturability. This approach often results in lightweight yet robust structures, especially valuable in electric vehicles where efficiency is critical.

AI-driven optimization reduces material usage, lowers costs, and shortens development cycles without compromising safety or performance.

Aerodynamics and performance enhancement AI significantly improves aerodynamic design by:

- Predicting airflow behavior using machine-learning models
- Reducing reliance on expensive wind-tunnel testing
- Rapidly iterating body shapes to minimize drag and improve stability

These tools allow engineers to test more design variations early in the development process, improving overall vehicle efficiency.



Interior design and human-centered innovation AI plays an increasingly important role in designing vehicle interiors:

- Analyzing driver posture, reach, and visibility
- Simulating human-machine interaction (HMI)
- Personalizing cabin layouts for comfort and safety

By incorporating real-world usage data, AI helps create interiors that are more intuitive, inclusive, and user-friendly.



Materials, sustainability, and manufacturing alignment AI assists designers in selecting optimal materials based on:

- Weight, strength, and durability
- Environmental impact and recyclability
- Compatibility with manufacturing processes

This integration supports sustainable design practices and ensures that AI-generated designs can be efficiently produced at scale.

Simulation, safety, and validation

Traditional testing methods are time-consuming and costly
AI enhances simulation and validation by:

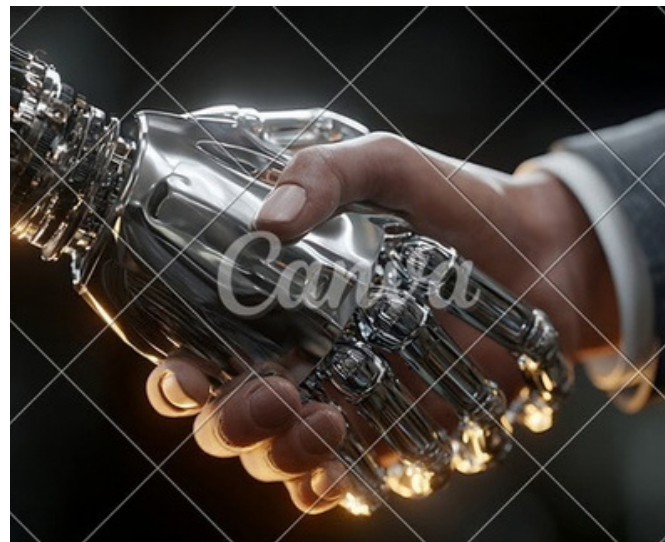
- Predicting crash outcomes and structural weaknesses
- Improving digital twin accuracy
- Identifying design flaws before physical prototyping

This leads to safer vehicles and faster regulatory compliance.



Human-AI collaboration in automobile design:

Despite its growing influence, AI does not replace human designers. Instead, it enhances their capabilities. Designers provide creativity, emotion, and brand vision, while AI handles optimization and complex analysis. The final design remains a human decision, informed by AI-driven insights.



Challenges and ethical considerations
The adoption of AI in automobile design
presents challenges:

- Ensuring transparency and trust in AI-generated designs
- Protecting intellectual property
- Integrating AI tools with existing CAD and PLM systems
- Meeting safety and regulatory requirements

Addressing these issues is essential for responsible and effective AI adoption.

AI is transforming automobile designing into a faster, smarter, and more collaborative process. By expanding creative possibilities and optimizing engineering outcomes, AI enables the development of safer, more efficient, and more innovative vehicles. As the technology continues to evolve, the future of automobile design will be defined not by machines alone, but by the synergy between human creativity and artificial intelligence.



Driverless Cars: ***The Future of*** ***Autonomous*** ***Mobility***

2301050936
ROSHAN SHAJU

The concept of driverless cars, also known as autonomous vehicles, represents one of the most revolutionary advancements in modern transportation. These vehicles are designed to operate with little or no human intervention, using advanced software, artificial intelligence (AI), and sensor technologies. As research and real-world testing accelerate, driverless cars are steadily moving from science fiction toward everyday reality.





What is a driverless car?

A driverless car is a vehicle capable of sensing its environment, making decisions, and navigating roads without human control. It relies on a combination of technologies such as cameras, radar, lidar, GPS, and AI-powered algorithms to detect obstacles, interpret traffic conditions, and ensure safe driving. Autonomous vehicles are often categorized into levels (Level 0 to Level 5), with Level 5 representing full automation where no human driver is required under any conditions.



Key technologies behind driverless cars

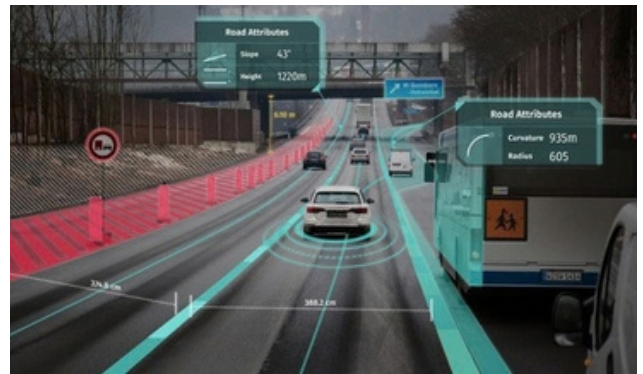
>Artificial Intelligence and Machine Learning:

AI enables driverless cars to recognize objects, predict movements, and make driving decisions. Machine learning models continuously improve by analyzing vast amounts of driving data.



>Sensors and perception systems:

Cameras, radar, and lidar provide a 360-degree view of the surroundings, helping the vehicle identify pedestrians, vehicles, road signs, and lane markings.



>Navigation and mapping:

High-definition maps combined with real-time GPS data allow autonomous vehicles to determine precise location and plan optimal routes.



>Control systems:

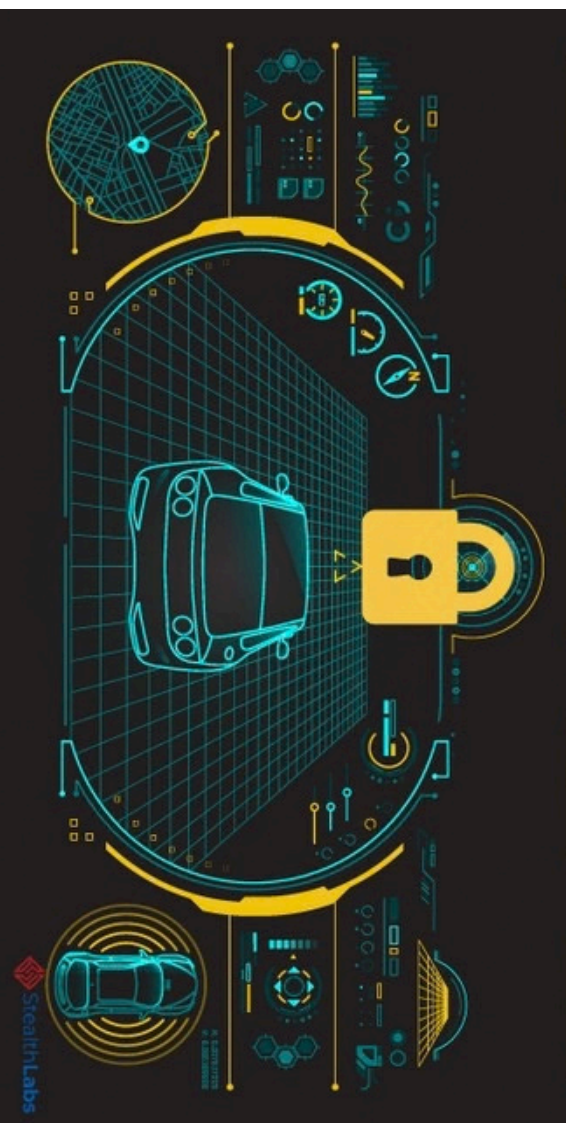
Advanced control software manages steering, braking, and acceleration to ensure smooth and safe movement.





Benefits of driverless cars

- Improved roads safety: Human error is a leading cause of accidents; automation can significantly reduce this risk.
- Increased mobility: Driverless cars can assist elderly and disabled individuals who cannot drive.
- Reduced traffic congestion: Autonomous systems can optimize traffic flow and reduce delays.
- Enhanced fuel efficiency: AI-driven driving can minimize unnecessary acceleration and braking.
- Time efficiency: Passengers can use travel time productively instead of focusing on driving.



Challenges and concerns

Despite their promise, driverless cars face several challenges:

- Ensuring safety in complex and unpredictable environments
- High development and infrastructure costs
- Cybersecurity risks and data privacy concerns
- Legal and ethical issues, including liability in accidents
- Public trust and acceptance

Overcoming these challenges is critical for widespread adoption.

Current applications and progress

Autonomous vehicle technology is already being tested and deployed in limited scenarios such as:

- Self-driving taxis and ride-hailing services
- Autonomous delivery vehicles
- Driver assistance systems in modern cars

Major automotive and technology companies continue to invest heavily in research and testing.

The future of driverless cars:

As technology matures, driverless cars are expected to become safer, more affordable, and more widely available. Integration with smart cities, improved regulations, and advancements in AI will further accelerate adoption. In the long term, autonomous vehicles have the potential to reshape urban planning, transportation systems, and daily life.

Driverless cars represent a major step toward intelligent and automated transportation. While challenges remain, the benefits in terms of safety, efficiency, and accessibility make autonomous vehicles a promising solution for the future of mobility. With continued innovation and responsible deployment, driverless cars may soon become a common sight on roads around the world.

3D Printing in **Automobile** **Manufacturing**

2301050940
SAYOOJTS

The automobile industry is constantly evolving to adopt new technologies that improve efficiency, reduce costs, and enable innovation. One such transformative technology is 3D printing, also known as additive manufacturing. By building components layer by layer directly from digital designs, 3D printing is changing how vehicles are designed, tested, and manufactured.



What is 3D printing?

3D printing is a manufacturing process in which objects are created by depositing material layer by layer based on a digital model. Unlike traditional manufacturing methods that remove material (subtractive manufacturing), 3D printing adds material only where needed, reducing waste and increasing design flexibility.

Applications of 3D printing in the automobile industry

1. Prototyping and product development

3D printing allows automotive manufacturers to quickly produce prototypes of parts and components. This significantly reduces development time and enables engineers to test designs early, make improvements, and accelerate innovation.

2. Lightweight and complex components

Additive manufacturing enables the creation of complex geometries that are difficult or impossible to produce using conventional methods. These lightweight components help improve fuel efficiency and extend the driving range of electric vehicles.

3. Tooling and fixtures

Automakers use 3D printing to produce jigs, fixtures, molds, and assembly tools. These tools are faster to manufacture, customizable, and cost-effective, improving production efficiency on the factory floor.

4. Customization and personalization

3D printing supports customized interior parts, trim components, and accessories. Manufacturers can offer personalized designs without expensive tooling changes.

5. Spare parts and on-demand manufacturing

Automotive companies can print spare parts on demand, reducing inventory costs and ensuring availability for older vehicle models. This is especially useful for low-volume or discontinued parts.



Materials used in automotive 3D printing

- Plastics (ABS, PLA, Nylon)
- Composites (carbon fiber–reinforced polymers)
- Metals (aluminum, steel, titanium)
- Rubber-like materials for seals and gaskets

Advances in material science continue to expand automotive applications.

Benefits of 3D printing in automobile manufacturing

- Faster design and development cycles
- Reduced material waste
- Cost-effective low-volume production
- Improved design freedom
- Rapid customization
- Reduced tooling and storage requirements

Challenges and limitations

Despite its advantages, 3D printing faces challenges:

- High initial investment in industrial-grade printers
- Slower production speeds compared to mass manufacturing
- Material strength and durability limitations for some applications
- Quality control and standardization issues

The future of 3D printing in automobiles:

As printer speeds improve and material options expand, 3D printing is expected to move beyond prototyping into large-scale production. Combined with AI-driven design and automation, additive manufacturing will play a key role in producing lighter, smarter, and more sustainable vehicles.

3D printing is reshaping automobile manufacturing by enabling faster development, greater customization, and innovative design possibilities. While it may not replace traditional mass production entirely, it is becoming an essential tool that complements conventional manufacturing methods and supports the future of automotive innovation.



Intelligent Traffic *Systems*

2301050941
SIJO SUNNY

Rapid urbanization and the growing number of vehicles have made traffic congestion, accidents, and pollution major challenges in modern cities.

Intelligent Traffic Systems (ITS) use advanced technologies such as artificial intelligence, sensors, communication networks, and data analytics to manage traffic efficiently, improve road safety, and enhance mobility.

What are Intelligent Traffic Systems?

Intelligent Traffic Systems are technology-driven solutions that collect, analyze, and use real-time traffic data to optimize the movement of vehicles and pedestrians. ITS integrates transportation infrastructure with information and communication technologies to create smarter and safer roads.

Key components of Intelligent Traffic Systems:

1. Traffic sensing technologies

ITS relies on sensors such as cameras, radar, loop detectors, and GPS data from vehicles to monitor traffic flow, speed, and congestion levels in real time.

2. Communication systems

Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication enable vehicles and traffic control centers to exchange information, improving coordination and response times.

3. Traffic management centers

Centralized control centers analyze data using AI and analytics tools to manage traffic signals, detect incidents, and guide emergency responses.

4. Smart traffic signals

Adaptive traffic signals adjust signal timings based on real-time traffic conditions, reducing waiting time and improving intersection efficiency.

5. Traveler information systems

ITS provides real-time information to road users through mobile apps, digital signboards, and navigation systems, helping drivers choose optimal routes.

Applications of Intelligent Traffic Systems

- Congestion management and traffic flow optimization
- Accident detection and incident management
 - Electronic toll collection
 - Public transport management
 - Parking management systems
 - Emergency vehicle prioritization

Benefits of Intelligent Traffic Systems

- Reduced traffic congestion
- Improved road safety
- Lower fuel consumption and emissions
- Faster emergency response times
- Enhanced travel comfort and efficiency

Challenges in implementing ITS

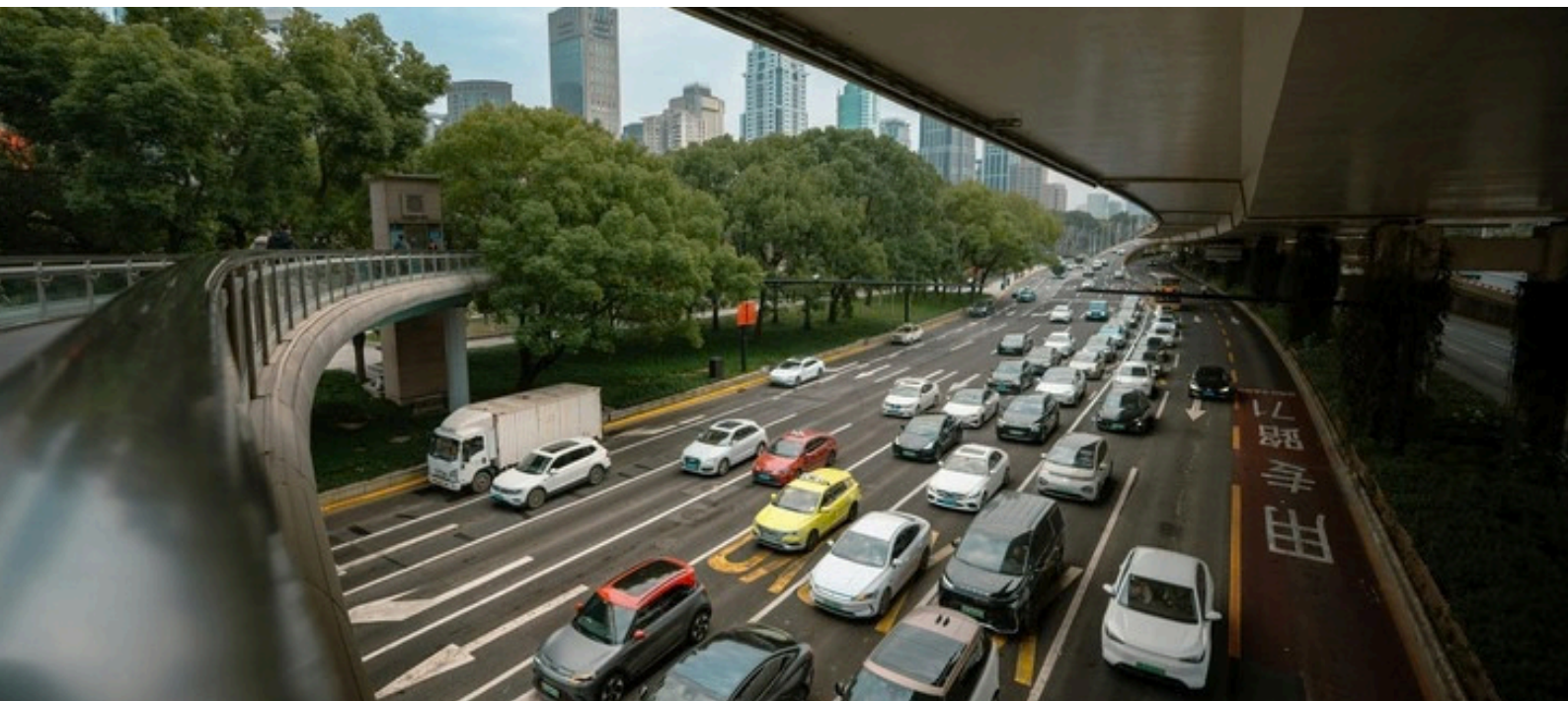
- High installation and maintenance costs
- Data privacy and cybersecurity concerns
- Integration with existing infrastructure
- Requirement for skilled personnel and coordination between agencies



Future of Intelligent Traffic Systems

The future of ITS lies in integration with autonomous vehicles, smart cities, and 5G communication networks. AI-driven predictive traffic management, real-time decision-making, and connected vehicle ecosystems will further improve urban mobility and sustainability.

Intelligent Traffic Systems play a vital role in addressing modern transportation challenges. By combining advanced technologies with traffic infrastructure, ITS enables safer, more efficient, and environmentally friendly transportation systems, paving the way for smarter cities and improved quality of life.



Advanced Manufacturing Materials in the Automobile Industry

**2301050943
YADHU KRISHNAN V S**

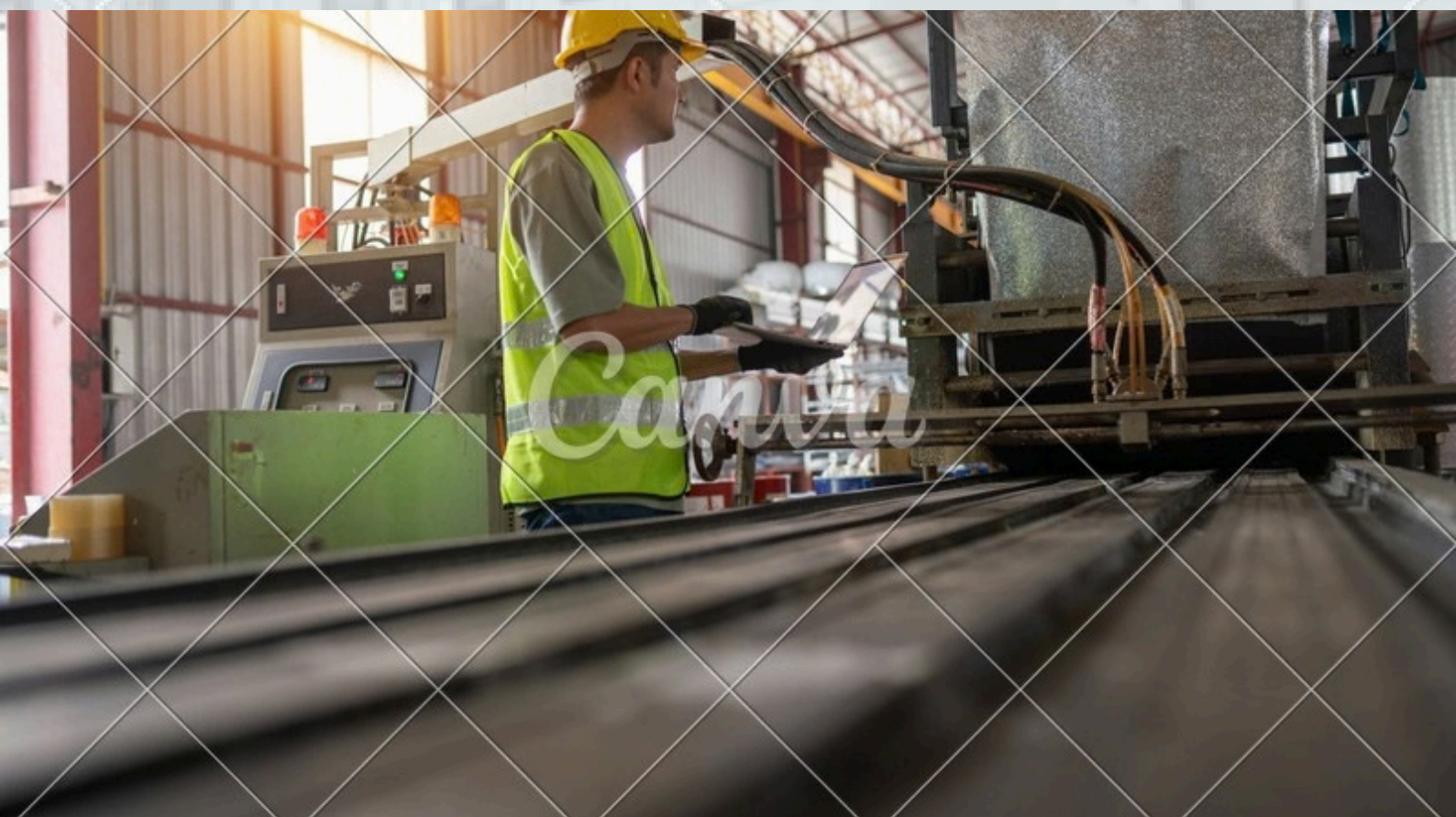
The automobile industry is continuously evolving to meet demands for improved fuel efficiency, safety, performance, and sustainability. One of the key drivers of this evolution is the use of advanced manufacturing materials. These materials enable the production of lighter, stronger, safer, and more environmentally friendly vehicles while supporting modern manufacturing techniques.



Importance of advanced materials in automobiles

Advanced materials help manufacturers:

- Reduce vehicle weight and improve fuel efficiency
- Enhance safety and crash performance
- Increase durability and corrosion resistance
- Support electric vehicle (EV) and autonomous vehicle technologies
- Meet stringent environmental and emission regulations



Types of advanced manufacturing materials

1. Advanced high-strength steel (AHSS)

Advanced high-strength steels offer excellent strength-to-weight ratios and improved crash performance.

- Used in body structures and safety components
- Cost-effective and recyclable
- Improves passenger safety while reducing weight

2. Aluminum alloys

Aluminum is widely used due to its lightweight and corrosion resistance.

- Common in body panels, engine blocks, and chassis components
- Improves fuel efficiency and EV driving range
- Easy to recycle

3. Magnesium alloys

Magnesium is one of the lightest structural metals.

- Used in steering wheels, seat frames, and transmission cases
- Offers significant weight reduction
- Requires advanced processing due to lower strength compared to steel

4. Carbon fiber-reinforced polymers (CFRP)

CFRP materials provide exceptional strength and stiffness with very low weight.

- Used in high-performance and luxury vehicles
- Enhances acceleration and handling
- High cost limits mass-market adoption

5. Polymer composites and plastics

Advanced polymers and composites are increasingly used in automotive manufacturing.

- Applied in interiors, exterior panels, and under-the-hood components
- Improve design flexibility and corrosion resistance
- Reduce manufacturing costs

6. Advanced glass materials

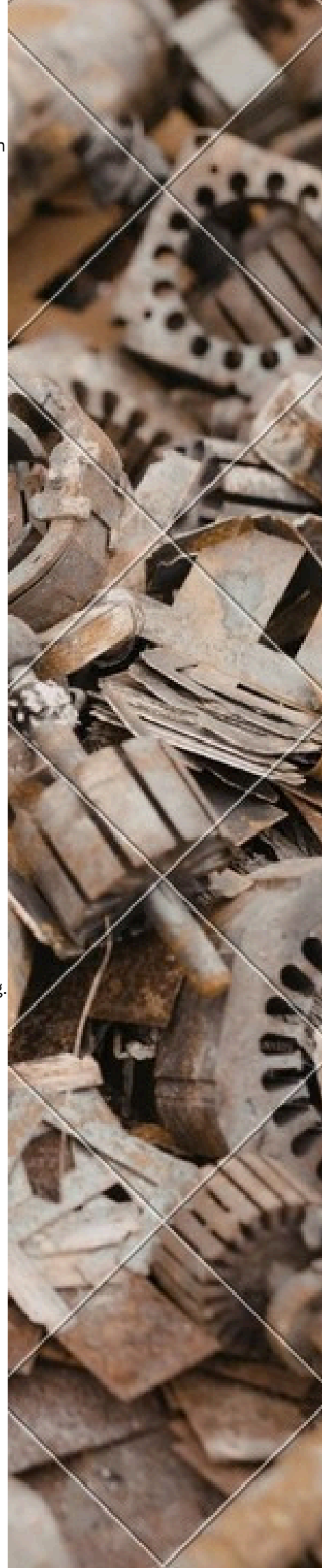
Modern vehicles use specialized glass materials for safety and comfort.

- Laminated and tempered safety glass
- Smart glass for heat and light control
- Improves visibility and passenger protection

7. Battery and energy materials (for EVs)

Electric vehicles rely on advanced materials for energy storage.

- Lithium-ion battery materials
- Solid-state electrolytes (emerging technology)
- Thermal management materials for safety and efficiency



Manufacturing technologies supporting advanced materials

- 3D printing (additive manufacturing)
- Advanced welding and joining techniques
- Hot stamping and hydroforming
- Automation and robotics

Benefits of advanced materials

- Improved vehicle performance and efficiency
- Enhanced safety and durability
- Lower emissions and environmental impact
- Better design freedom and aesthetics

Challenges in using advanced materials

- High material and processing costs
- Recycling and sustainability concerns
- Complex manufacturing requirements
- Need for skilled workforce and advanced equipment



Future trends

The future of automotive materials includes:

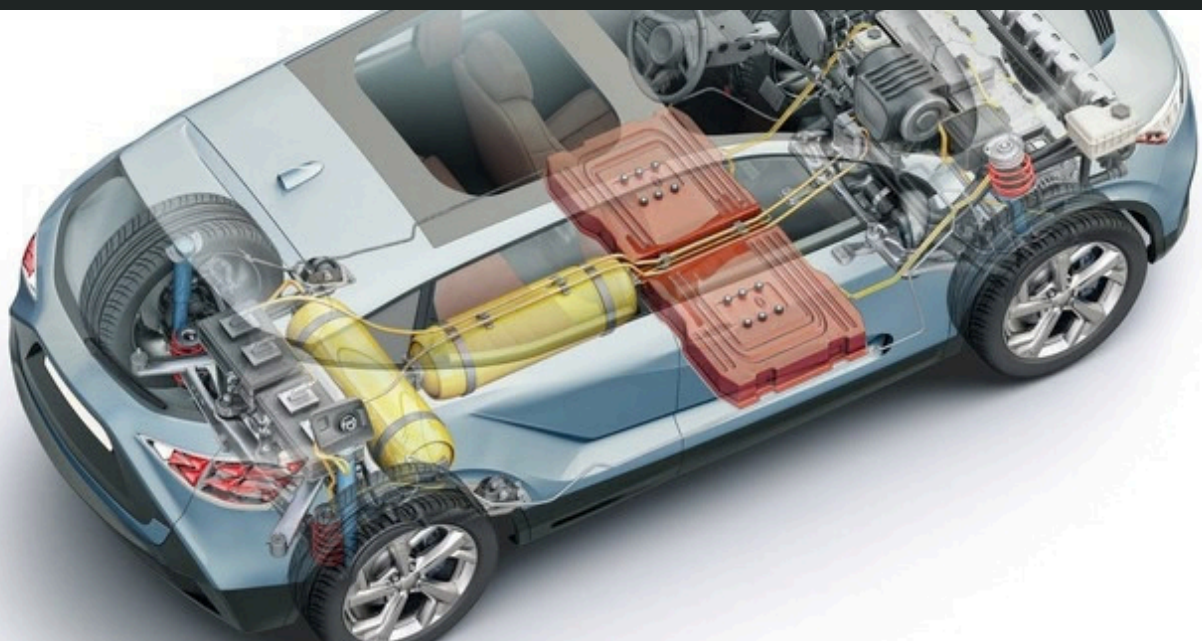
- Greater use of sustainable and recyclable materials
- Lightweight materials for electric and autonomous vehicles
- Integration of AI and digital twins in material selection
- Development of solid-state batteries and smart materials

Advanced manufacturing materials play a critical role in shaping the modern automobile industry. By enabling lighter, safer, and more efficient vehicles, these materials support technological innovation and environmental sustainability. As manufacturing techniques continue to evolve, advanced materials will remain central to the future of automotive design and production.

Camless Engines: **The Future of** **Automotive** **Powertrains**

2301051570
ABHINAND C V

The internal combustion engine (ICE) has been the heart of automobiles for over a century. Traditionally, engines use camshafts to control the opening and closing of intake and exhaust valves. However, with the demand for higher efficiency, lower emissions, and better performance, a revolutionary technology has emerged: the camless engine. Camless engines replace traditional mechanical camshafts with electronic or electro-hydraulic actuators to control the engine valves. This allows precise, independent control of each valve, opening up possibilities that conventional engines cannot achieve.

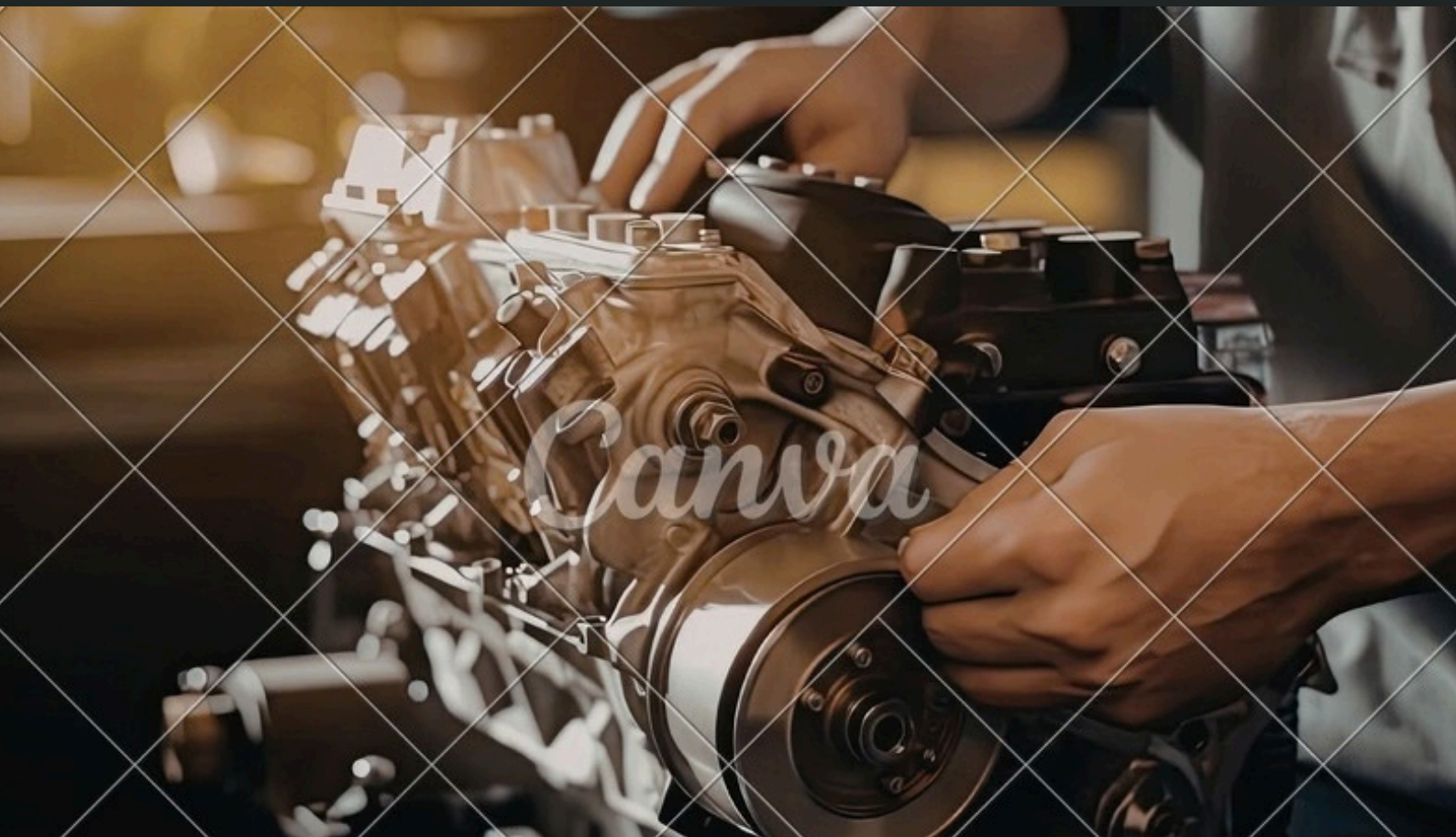


How Camless Engines Work

In a camless engine:

- Electromagnetic, hydraulic, or pneumatic actuators control valve timing and lift
- Engine control units (ECUs) determine exactly when and how long each valve opens
- Valve movement is no longer mechanically fixed to crankshaft rotation

This precise control is known as Fully Variable Valve Timing (VVT), but camless engines take it further by completely eliminating the camshaft.



Advantages of Camless Engines

1. Improved fuel efficiency

- Valve timing can be optimized for any driving condition

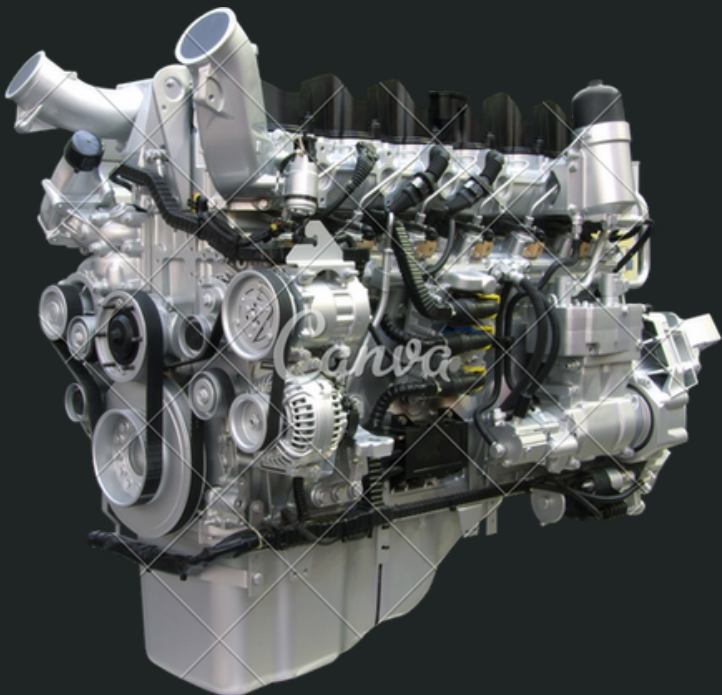
- Reduces pumping losses and improves combustion efficiency

2. Higher performance

- Independent control of intake and exhaust valves allows better air-fuel mixture
- Optimizes torque and power across a wider RPM range
- 3. Reduced emissions
 - Better combustion leads to lower CO₂ and NO_x emissions
- Engine can run leaner under part-load conditions
- 4. Flexible operation modes
 - Cylinder deactivation is easier and more efficient
 - Supports alternative fuels and hybrid integration

5. Simplified mechanical design

- Eliminates camshaft, timing belts/chains, and related components
- Reduces engine weight and mechanical complexity



Challenges in Camless Engine Adoption

- High cost of actuators and control systems
- Durability and reliability under extreme conditions
- Electronic control complexity requiring advanced ECUs
- Limited mass production experience compared to traditional engines

Applications and Real-World Examples

- Freevalve (Koenigsegg): One of the most well-known camless engines, using pneumatic-hydraulic actuators to control valves independently
- Concept engines by AVL, Ricardo, and other research labs focusing on efficiency and hybrid integration

Future of Camless Engines

Camless engines are not just about replacing camshafts—they are about transforming engine operation:

- Integration with hybrids and electric systems for optimal energy management
- Smart, adaptive engines controlled by AI for real-time optimization
- Potential for downsized, lightweight engines with higher efficiency and lower emissions

While mass adoption may take time due to costs and engineering challenges, camless engines represent a major leap forward in ICE technology.

Camless engines are redefining the possibilities of internal combustion. By eliminating mechanical constraints, they offer unmatched flexibility in valve control, improving efficiency, performance, and emissions. As automotive technology continues to evolve toward electrification and smarter engines, camless designs could become a cornerstone of high-performance, low-emission vehicles in the near future.

i-SMART **Technology in** **MG Cars**

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NIHAL P A

Connected car technology that turns your vehicle into a smart, internet-ready mobility hub

Modern vehicles are no longer just mechanical machines — they are increasingly sophisticated digital platforms. i-SMART is MG Motor's connected car system that integrates artificial intelligence (AI), internet connectivity, mobile control, and smart features to elevate the driving experience. This technology has helped make MG vehicles among the most advanced connected cars in their class.



What is i-SMART?

i-SMART is an intelligent connected car platform developed by MG that combines hardware, software, cloud services and apps to create a seamless driving experience. It connects your car to the internet, to your smartphone, and even to your lifestyle — enabling control, communication, entertainment and smart safety features.

At its core, i-SMART uses:

- Artificial Intelligence (AI) and machine learning
- Cloud connectivity
- Embedded SIM (eSIM) with 5G-ready support
- Voice recognition and mobile app integration

All of which work together to make your car smarter and continually improving over time.



Key Features of i-SMART Technology

◆ Internet Connectivity

MG cars equipped with i-SMART have a built-in M2M embedded SIM, ready for 5G and future networks. This keeps the vehicle connected for updates and intelligent services.

◆ Over-The-Air (OTA) Updates

Just like a smartphone, your car can receive software and feature updates wirelessly — no dealership visit needed. OTA updates improve infotainment, navigation, safety alerts and more over time.

◆ AI Voice Assistant (“Hello, MG”)

Say “Hello MG” to activate the voice assistant, which understands natural speech and over 100 voice commands — such as controlling climate, sunroof, music, navigation and more. It’s tuned for local language patterns and accents.

◆ Smart Mobile App Integration

The MG i-SMART App turns your smartphone into a command centre for your vehicle. You can use it to:

- Lock/unlock doors remotely
- Start the engine or AC
- Check vehicle status (tyre pressure, fuel/battery, etc.)
- Find your parked car
- Set geofencing alerts (alerts when your car leaves/enters a set area)

All of this happens through the mobile app connected to the car’s system.

◆ Real-Time Navigation & Assistance

The system includes built-in navigation apps with live traffic updates and route planning. Weather forecasts, music streaming services and points-of-interest guides are also supported directly through the car’s display.

◆ Safety and Emergency Features

i-SMART includes emergency calling (e-Call) — automatically contacting MG’s Pulse Hub and emergency contacts if airbags deploy. It can also alert you if unusual activity is detected and assist with roadside support.

i-SMART Next Gen & EV Integration

MG has expanded the system in newer models and EVs — such as i-SMART 2.0 — to track charging status, EV range, CO₂ savings, range alerts and navigation optimized for electric driving. This shows how i-SMART evolves with vehicle technology, especially in electrified cars.

Why i-SMART Matters:

i-SMART illustrates how digital technology is transforming the automobile from a purely mechanical product into a connected lifestyle platform. It enhances convenience, increases safety, and keeps cars up to date long after purchase — much like modern smartphones and computers. As vehicles become more connected and data-driven, systems like i-SMART are a key innovation shaping the future of mobility.

i-SMART Technology is a comprehensive connected car ecosystem by MG that:

- Brings internet connectivity and cloud services into vehicles
- Enables remote control and mobile integration
- Provides advanced voice and AI features
- Offers over-the-air upgrades and real-time smart services

Through i-SMART, MG is pushing the automobile industry toward smarter, safer and more digitally integrated driving experiences — marking a significant shift in how drivers interact with their cars.





Biometric Vehicle Access: The Future of Secure Mobility

2201051592
KRISHNADAS C.P

As vehicles become smarter and more connected, traditional key-based access is giving way to biometric authentication systems. Biometric vehicle access uses unique physical or behavioral traits—such as fingerprints, facial features, voice, or even iris patterns—to grant secure entry and start the engine, offering both convenience and advanced security.

What is Biometric Vehicle Access?

Biometric vehicle access is a system that identifies a driver or passenger based on biometric identifiers, replacing or complementing conventional keys, key fobs, or PIN codes. These systems are integrated with the vehicle's onboard electronics and can control:

- Door locking and unlocking
- Engine start/stop
- Personal settings (seat, mirrors, infotainment)

By using something unique to the individual, it ensures that only authorized users can operate the vehicle.

Common Biometric Methods in Vehicles

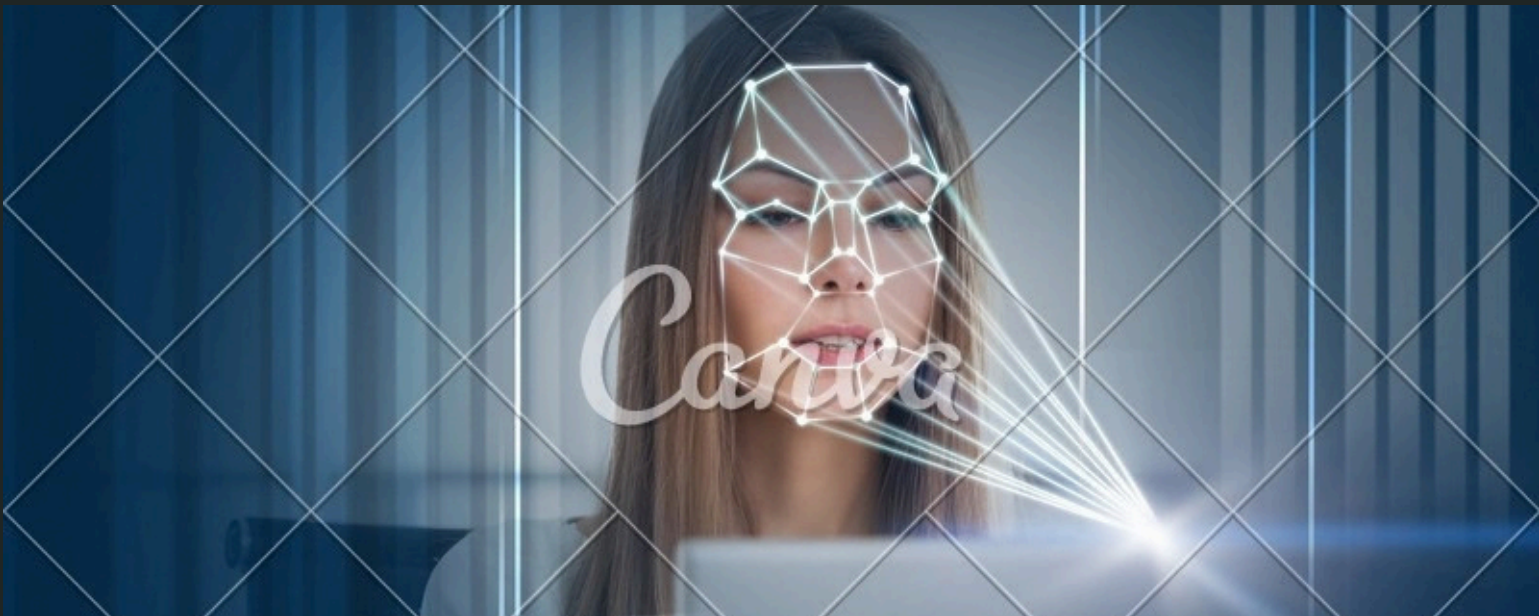
1. Fingerprint Recognition

- Scans a user's fingerprint on a sensor embedded in the door handle or start button
- Grants access and optionally activates personalized driver settings



2. Facial Recognition

- Uses cameras to identify the driver's face before unlocking the vehicle or starting the engine
- Can also detect fatigue or alert if an unauthorized person tries access



3. Iris Recognition

- High-security option for luxury or autonomous vehicles
- Identifies users based on the unique patterns of the iris



4. Voice Recognition

- Activates vehicle systems through voice commands
- Adds a layer of authentication when combined with other biometrics



Advantages of Biometric Vehicle Access

> Enhanced Security

- o Eliminates risks of lost or cloned keys
- o Reduces theft by unauthorized users

> Convenience

- o No need to carry keys or remember PINs
- o Unlocks and adjusts personalized settings automatically

> Personalization

- o Seats, mirrors, climate control, and infotainment settings can adapt to the recognized user

> Integration with Smart Systems

- o Works seamlessly with connected car technology and mobile apps
- o Enables usage tracking and remote monitoring

Challenges and Limitations

- High cost: Biometrics sensors and processing systems are expensive
- Environmental factors: Dirt, sunlight, or low light can affect sensor accuracy
- Privacy concerns: Storage of biometric data must comply with regulations and cybersecurity standards
- System reliability: Needs backup options in case of sensor failure



Real-World Applications

- Luxury brands: BMW, Mercedes-Benz, and Audi are experimenting with fingerprint and facial recognition for premium models
- Smart EVs: Some electric vehicles integrate biometric access for enhanced security and personalization
- Concept cars: Several automakers showcase iris- or voice-based access in futuristic prototypes

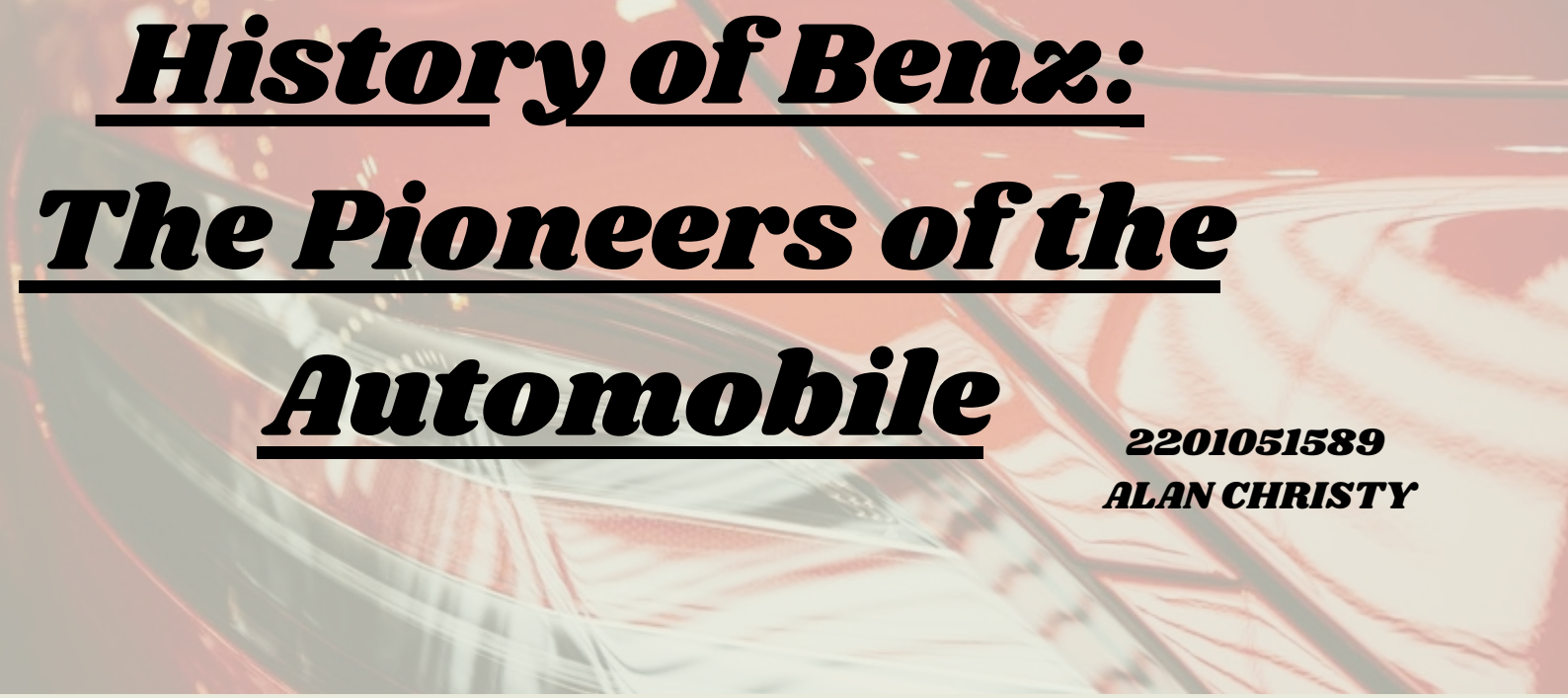
Future of Biometric Vehicle Access

With the rise of connected and autonomous vehicles, biometric access will likely become standard, offering:

- Multi-factor authentication combining biometrics and smartphones
- Continuous monitoring for driver authentication
- Integration with smart city infrastructure for seamless vehicle-to-user interaction

The ultimate goal is a keyless, secure, personalized, and intelligent driving experience.

Biometric vehicle access represents a major step toward smart, secure, and personalized mobility. By combining cutting-edge sensors, AI, and connected car technology, it not only improves security but also enhances user convenience and personalization. As costs decrease and technology matures, biometric access is likely to become a common feature in modern vehicles.



History of Benz: **The Pioneers of the** **Automobile**

2201051589
ALAN CHRISTY

Benz, one of the most iconic names in automotive history, is synonymous with the invention of the modern automobile. The journey of Benz is a story of innovation, engineering genius, and the birth of personal mobility.

Early Life of Karl Benz

- Karl Benz (1844–1929) was a German mechanical engineer and inventor.
- He studied mechanical engineering in Karlsruhe and initially worked in various engineering and machinery roles.
- Benz was passionate about engines and combustion technology, which laid the foundation for his later innovations.

Invention of the First Automobile

- In 1885, Karl Benz built the Benz Patent-Motorwagen, widely recognized as the world's first automobile designed to be powered by an internal combustion engine.

- Key features:

- Single-cylinder, four-stroke engine

- Three wheels

- Top speed of about 16 km/h (10 mph)

- In 1886, Benz was granted a patent for his invention (Patent No. 37435), marking the official birth of the modern automobile.

Bertha Benz and the First Long-Distance Journey

- Karl Benz's wife, Bertha Benz, played a crucial role in promoting the invention.
- In 1888, she undertook the first long-distance car trip of 66 km from Mannheim to her mother's home in Pforzheim, demonstrating the vehicle's reliability.
- Her journey helped publicize the Motorwagen and proved the practicality of the automobile.

Formation of Benz & Cie.

- In 1871, Karl Benz co-founded Benz & Cie., a company dedicated to engines and mechanical devices.
- After the success of the Motorwagen, Benz & Cie. began producing automobiles commercially, focusing on engineering precision and quality.

Merger with Daimler

- In 1926, Benz & Cie. merged with Daimler-Motoren-Gesellschaft (DMG), the company founded by Gottlieb Daimler and Wilhelm Maybach.
- The merger formed Mercedes-Benz, combining innovation and engineering expertise.
- Mercedes-Benz went on to become a global leader in luxury vehicles, commercial trucks, and automotive technology.

Legacy of Benz

- Karl Benz is celebrated as the father of the automobile.
- Benz & Cie. and later Mercedes-Benz set standards for:
 - Internal combustion engines
 - Safety innovations
 - Automotive luxury and engineering excellence
- Today, Mercedes-Benz continues to push boundaries in electric vehicles, autonomous technology, and smart mobility.

Key Milestones

<u>Year</u>	<u>Milestone</u>
1844	Karl Benz is born
1871	Founding of Benz & Cie.
1885	Benz Patent-Motorwagen built
1886	Patent granted for Motorwagen
1888	Bertha Benz's historic journey
1926	Merger with DMG to form Mercedes-Benz
21st Century	Leader in EVs, autonomous tech, and luxury cars

The history of Benz is the story of innovation, determination, and vision. From Karl Benz's first Motorwagen to today's technologically advanced Mercedes-Benz vehicles, the legacy continues to inspire the automotive world. Bertha Benz's journey and Karl Benz's inventions laid the foundation for modern personal mobility, making Benz a true pioneer in automotive history.

Active Health Monitoring in Automobiles

2201051590
ANTONY VARGHESE

Modern vehicles are becoming increasingly sophisticated, with safety, performance, and user convenience at the forefront. One of the emerging technologies enhancing vehicle reliability and driver safety is Active Health Monitoring (AHM).

Active Health Monitoring refers to systems within a vehicle that continuously monitor the health of critical components, alerting drivers or service personnel before failures occur. This proactive approach reduces breakdowns, enhances safety, and lowers maintenance costs.



What is Active Health Monitoring?

Active Health Monitoring uses sensors, diagnostics, and software algorithms to track the condition of various vehicle systems in real time. Unlike traditional maintenance, which relies on fixed schedules or reactive inspections, AHM predicts potential issues and helps prevent failures.

Key Components Monitored

Engine Health

- o Monitors oil levels, coolant temperature, fuel injection, and engine performance
- o Detects abnormal vibrations, misfires, or overheating

Battery and Electrical Systems

- o Tracks battery charge, alternator performance, and electronic control units (ECUs)
- o Particularly important in electric and hybrid vehicles

Brake System

- o Monitors brake pad wear, fluid levels, and ABS functionality
- o Alerts driver to impending issues for safety

Tires and Suspension

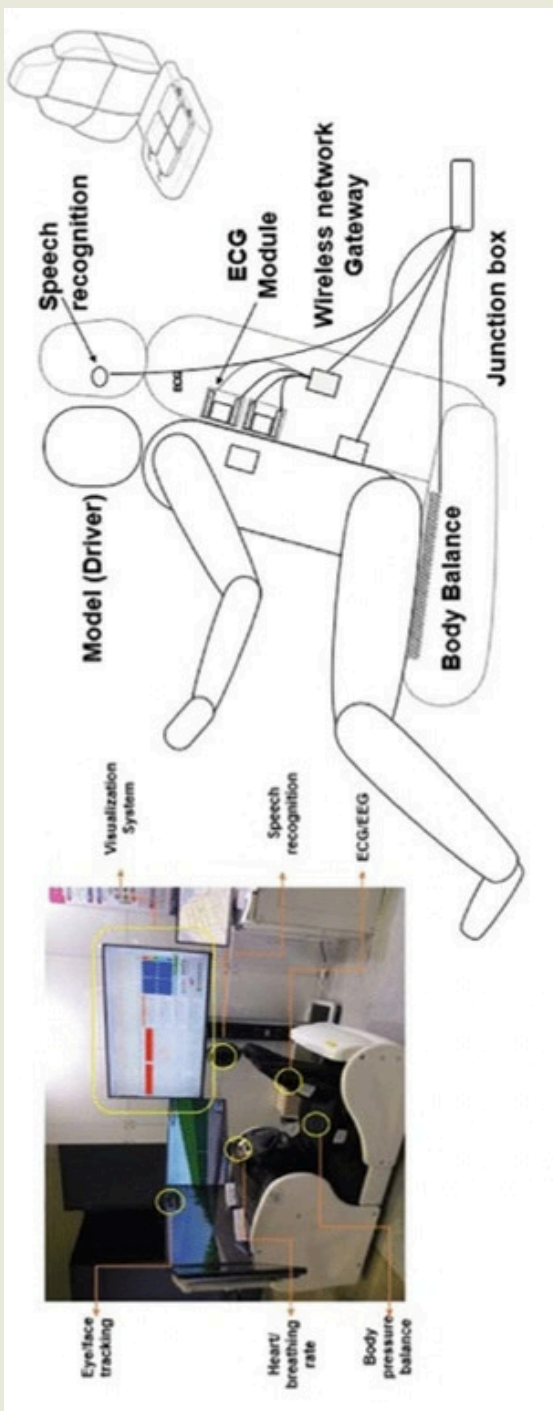
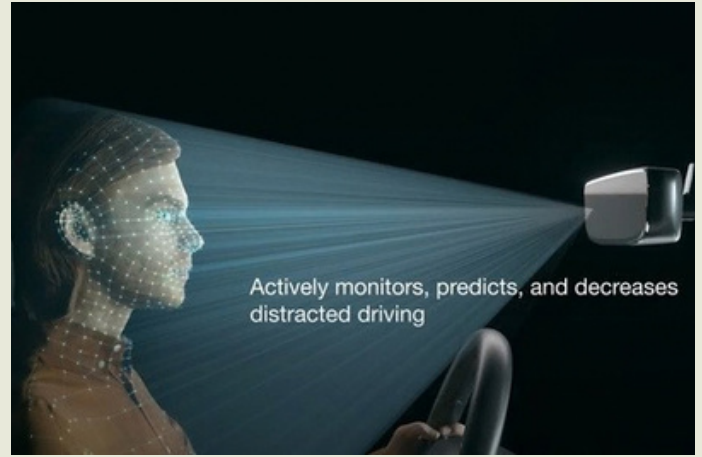
- o Tire pressure monitoring and wear detection
- o Suspension component stress monitoring

Transmission and Drivetrain

- o Checks fluid levels, gear engagement, and clutch/torque converter performance

Technologies Used

- IoT Sensors: Measure temperature, pressure, vibration, and other physical parameters
- Artificial Intelligence (AI): Analyzes data to predict failures and maintenance needs
- Telematics and Cloud Connectivity: Sends real-time vehicle health reports to drivers or service centers
- Dashboards and Mobile Apps: Provide alerts, recommendations, and performance summaries



Benefits of Active Health Monitoring

- Enhanced Safety
 - Early detection of component failure prevents accidents
- Reduced Maintenance Costs
 - Maintenance is performed only when needed, avoiding unnecessary service
- Extended Vehicle Lifespan
 - Continuous monitoring reduces wear and tear
- Improved Reliability
 - Drivers can avoid sudden breakdowns or roadside emergencies
- Data-Driven Insights
 - Manufacturers can gather usage data to improve future vehicle designs

Applications in Modern Vehicles

- LuxuryCars: Mercedes-Benz, BMW, and Audi integrate AHM for engine, battery, and brake monitoring
- Electric Vehicles (EVs): Tesla, MG, and NIO monitor battery health and thermal management systems
- Commercial Fleets: Trucks and buses use AHM for predictive maintenance to reduce downtime



Future Trends

- Integration with AI-powered predictive maintenance and autonomous vehicle systems
- Cloud-based health monitoring enabling remote diagnostics
- Combination with connected car platforms for seamless service scheduling
- Use of biometric monitoring to assess driver alertness alongside vehicle health

Active Health Monitoring is transforming vehicle maintenance from a reactive to a proactive model, enhancing safety, reliability, and cost efficiency. As cars become smarter and more connected, AHM will play a vital role in ensuring vehicles operate at peak performance while keeping drivers informed and safe.